

1 CLAIMS

2 What is claimed is:

3 1. A resonant optical filter, comprising:
4 a. a first transmission optical waveguide;
5 b. a second transmission optical waveguide; and
6 c. an optical resonator, evanescently optically coupled to each of the first and second
7 transmission waveguides for transferring a resonant optical signal between the first and
8 second transmission waveguides.

9 2. The resonant optical filter of Claim 1, wherein:
10 a. the first transmission optical waveguide transmits therethrough a plurality of optical
11 signals, each carried by a respective waveguide optical mode corresponding to an
12 optical channel of a WDM system;
13 b. the second transmission optical waveguide being arranged to transmit therethrough a
14 plurality of optical signals, each carried by a respective waveguide optical mode
15 corresponding to an optical channel of a WDM system;
16 c. each of the first and second transmission waveguides including an evanescent optical
17 coupling segment therein; and,
18 d. the optical resonator being positioned so that a portion of the resonant optical mode of
19 the resonator at least partially spatially overlaps the evanescent portion of the optical
20 mode in the first and second transmission waveguide optical coupling segments.

21 3. The optical filter of Claim 2, wherein the optical resonator includes a plurality of optical
22 resonator segments, at least two of the optical resonator segments being evanescently
23 optically coupled therebetween.

24 4. The resonant optical filter of Claim 3, wherein:
25 a. an optical signal entering the resonant optical filter through the first transmission optical
26 waveguide and carried by a WDM channel substantially resonant with an optical
27 resonance of at least one of the optical resonators is substantially transferred from the
28 first transmission of optical waveguide to the second transmission optical waveguide
29 and leaves the resonant optical filter through the second transmission optical
30 waveguide; and,

1 b. an optical signal entering the resonant optical filter through the first transmission optical
2 waveguide and carried by a WDM channel substantially non-resonant with any optical
3 resonance of the coupled-optical-resonator system substantially remains within the first
4 transmission optical waveguide and leaves the resonant optical filter through the first
5 transmission optical waveguide.

6 5. The resonant optical filter of Claim 3, wherein:

7 a. an optical signal entering the resonant optical filter through the second transmission
8 optical waveguide and carried by a WDM channel substantially resonant with an optical
9 resonance of the coupled-optical-resonator system is substantially transferred from the
10 second transmission optical waveguide to the first transmission optical waveguide and
11 leaves the resonant optical filter through the first transmission optical waveguide; and,
12 b. an optical signal entering the resonant optical filter through the second transmission
13 optical waveguide and carried by a WDM channel substantially non-resonant with any
14 optical resonance of the coupled-optical-resonator system substantially remains within
15 the second transmission optical waveguide and leaves the resonant optical filter through
16 the second transmission optical waveguide.

17 6. The resonant optical filter of Claim 3 wherein the filter functions as an optical WDM
18 slicer/interleaver.

19 7. A resonant optical filter for an optical WDM system, comprising:

20 a. a first transmission fiber-optic waveguide, the waveguide having a fiber-optic-taper
21 segment therein;
22 b. a second transmission fiber-optic waveguide, the second waveguide having a fiber-
23 optic-taper segment therein;
24 c. a resonator fiber having at least one fiber-ring resonator segments formed thereon, each
25 fiber-ring resonator being evanescently optically coupled together and thereby acting as
26 a single fiber-ring resonator;
27 d. the resonator fiber further including a taper positioner for engaging the fiber-optic-taper
28 segment of at least one of the first and second transmission fiber optic waveguides and
29 so as to reproducibly establish and stably maintain an evanescent optical coupling of the
30 fiber-ring resonator and at least one of the transmission fiber optic waveguides; and

1 e. wherein at least one of the fiber optic taper segments of the first and second
2 transmission fiber optic waveguides is partially wrapped around a portion of an outer
3 circumference of at least one fiber-ring resonator segment.

4 8. The resonant optical filter of Claim 7 wherein the resonator fiber includes a delocalized-
5 optical-mode suppressor.

6 9. The resonant optical filter of Claim 8, wherein the resonant frequencies of the fiber-ring
7 resonator segment have been modified by beam processing.

8 10. The resonant optical filter of Claim 7 wherein at least one of the fiber-optic-taper segments
9 of the first and second transmission fiber optic waveguides is longitudinally displaced from
10 the longitudinal midpoint of at least one of the fiber-ring resonator segments, thereby
11 substantially reducing undesirable taper-induced optical loss of at least one fiber-ring
12 resonator segments.

13 11. A method for dividing a plurality of optical signals transmitted by an optical WDM system
14 comprising the steps of receiving a plurality of optical signals, each carried by the
15 corresponding WDM channel, into a first transmission optical waveguide;
16 a. routing a first set of optical signals including at least one of the received optical signals
17 into a second transmission optical waveguide, the first set of optical signals being
18 substantially resonant with a fiber-ring resonator evanescently optically coupled to the
19 first and second transmission optical waveguides; and,
20 b. permitting a second set of optical signals to pass undisturbed along the first
21 transmission optical waveguide, the second set of optical signals including at least one
22 of the received optical signals and the second set of optical signals being substantially
23 non-resonant with any optical resonance of the fiber-ring resonator.

24 12. A method for combining a plurality of optical signals transmitted by an optical WDM
25 system, comprising the steps of:
26 a. receiving a first set of optical signals through a first transmission optical waveguide, the
27 first waveguide being evanescently coupled to an optical resonator, the first set of
28 optical signals being substantially non-resonant with any optical resonances of the
29 optical resonator;

1 b. receiving a second set of optical signals through a second transmission optical
2 waveguide, the second optical waveguide being evanescently optically coupled to an
3 optical resonator, the second set of optical signals being substantially resonant with an
4 optical resonance of the optical resonator; and,
5 c. routing through the optical resonator, at least one optical signal from the second set of
6 optical signals to the first transmission optical waveguide, thereby adding an additional
7 optical signal to the first set of optical signals transmitted in the first transmission
8 waveguide.

9 13. A method for dropping an optical signal transmitted by an optical WDM system comprising
10 the steps of:

11 a. receiving a plurality of optical signals, each carried by the corresponding WDM
12 channel, into the first transmission optical waveguide, the first waveguide being
13 evanescently optically coupled to a circumferential-mode optical resonator and at least
14 one of such signals is substantially resonant with an optical resonance of the
15 circumferential-mode optical resonator; and at least one of such signals is substantially
16 non-resonant with an optical resonance of the circumferential-mode optical resonator;
17 and,
18 b. routing to a second transmission optical waveguide the optical signals carried by a
19 WDM channel substantially resonant with an optical resonance of the circumferential-
20 mode optical resonator; the second waveguide also being evanescently optically
21 coupled to a circumferential-mode optical resonator.

22 14. A method for adding an optical signal transmitted by an optical WDM system comprising
23 the steps of:

24 a. receiving a first plurality of optical signals, each carried by the corresponding WDM
25 channel, from a first transmission optical waveguide, the first waveguide being
26 evanescently optically coupled to a circumferential-mode optical resonator, such signals
27 being substantially non-resonant with an optical resonance of the circumferential-mode
28 optical resonator; and,
29 b. receiving a second plurality of optical signals, each carried by the corresponding WDM
30 channel, from a second transmission optical waveguide, the second waveguide also
31 being evanescently optically coupled to the circumferential-mode optical resonator, at

least one of such second plurality of signals is substantially resonant with an optical resonance of the circumferential-mode optical resonator; and at least one of such second plurality of signals is substantially non-resonant with an optical resonance of the circumferential-mode optical resonator; and,

c. routing to the first transmission optical waveguide the optical signals from the second plurality of signals those signals which are substantially resonant with an optical resonance of the circumferential-mode optical resonator.

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